Frontline

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# USER'S GUIDE HELPS FORESTERS COMBAT STEM DECAY

by

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**CATEGORY:** Disease Management

**KEY WORDS:** internal stem decay, stain, rot, cull, hidden defects, economic impact

## INTRODUCTION

All of the commercially important tree species of Ontario are affected to some degree by internal stem decay or stain. These defects can have a serious impact on harvesting costs and efficiency, and on product values. For the most part, these are hidden defects, and are therefore difficult to assess or predict.

Considerable information on stem decays in Ontario and adjacent provinces and states has been published over the past 50 to 60 years. However, much of it is highly technical and of limited use to the field foresters responsible for dealing directly with decay problems. For this reason, I have written a compendium and user's guide on stem decay in non-scientific language for foresters (Basham 1991). The guide covers the stem-decay process, how to assess the extent of stem decay, the economic impact of stem decay, methods of combating it, and its effect on each of the major tree species of Ontario. In this publication, I have summarized not only the results of my 40 years of research on stem decays, but also relevant information from virtually all such studies conducted in or near Ontario.

This publication will be valuable to those foresters in government, industry and private practice who are concerned with forest management, and particularly with harvesting. A copy may be obtained by contacting Forestry Canada, Ontario Region. The present note is a brief outline of the contents of this publication.

## STEM DECAY: CAUSES AND EFFECTS

Stem decay is wood within the stem of a living tree that has been noticably weakened by the breakdown of some or all of its cell walls. A group of fungi called the Hymenomycetes are the cause of most stem decay. These fungi are capable of degrading and metabolizing cell-wall substances, causing a progressive reduction in the strength of the invaded woody tissues. In the advanced stages of decay, the wood loses virtually all structural strength.

Decay fungi are divided into two broad classes, "white rots" and "brown rots", on the basis of their effects on wood. Because white-rot fungi degrade lignin at a faster rate than cellulose, the resulting rotted wood is generally yellow or orange, with a stringy or spongy texture, and it may contain white pockets composed of almost pure cellulose. Brown-rot fungi degrade only the cellulose and hemicellulose in the cell wall and the resulting rotted wood is pale to medium brown, with a dry, cracked cubelike appearance.

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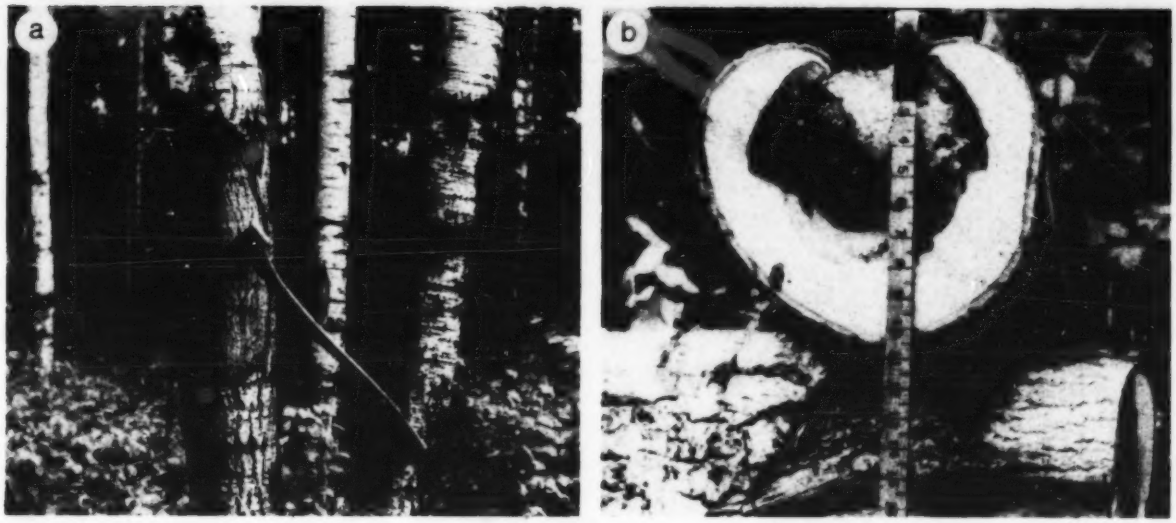


*Figure 1. Stem decay associated with severe stem wound on aspen. (a) standing tree, (b) felled tree with extensive advanced decay at the wound.*

## OCCURRENCE AND SPREAD OF DECAY

Most stem decay originates from airborne spores. Since the hyphae of germinating spores cannot penetrate unbroken bark, they must gain entry to the stem via branch stubs, dead branches, dead tops, and wounds caused by fire, logging, sunscald, frost, lightning or animals (Fig. 1).

Even when spores are deposited in such areas and germinate, successful invasion of the heartwood is by no means assured. First they must overcome intense competition from other microorganisms deposited on the same tissue. Next, there are the tree's own defence mechanisms to overcome. The most obvious of these is the tree's attempt to cover the wound by the formation of callus tissue. However, this is far too slow a defense except for the smallest wounds. More important is internal compartmentalization, in which living parenchyma cells in the vicinity of the wound react chemically and anatomically to form barriers that protect the wood behind the barrier from invasion by microorganisms and from further moisture loss. As might be expected, factors such as increasing age and poor site quality reduce a tree's vigor, and correspondingly increase its susceptibility to infection.

## ASSESSING THE EXTENT OF DECAY

Because of the impact of stem decay on utilization, some estimate of the extent of decay is critical in planning harvesting operations. Major over- or underestimations can have significant economic impacts. Unfortunately, because of the internal nature of stem decay and the unreliability of external indicators, accurate estimates of the extent of stem decay are not easy to obtain.

Tables have been prepared to indicate the average relationships between age and decay for most commercial forest species (Anon. 1978). With these tables and a knowledge of stand ages, rough estimates of cull percentages can be made. However, the best estimate is based on the extrapolation of data obtained from intensively measured, felled trees selected to represent the stands to which the results are to be applied.

## ECONOMIC IMPACT OF STEM DECAY

Stem decay causes losses in volume and product value for virtually all uses. Since decay attacks cell walls, pulp yield and quality are almost invariably reduced by the presence of decayed wood, with groundwood pulp suffering the greatest loss. In lumber manufacturing, reductions in product value and increases in product cost can be expected as the amount of decay increases. In veneer manufacturing, decayed heartwood can make it impossible to hold an otherwise-valuable log on the lathe. Losses caused by decay are less severe in the manufacture of waferboard, largely because much of the decayed wood breaks up and is separated out as "fines".

Although overall losses to stem decay are impossible to quantify accurately, they have been estimated at 9 million $m^3$ annually for Ontario. Another study estimated that 6.3% of the timber harvested annually in Ontario is culled as a result of stem decay. This means that a like proportion of the harvesting effort and expenditure is simply wasted. However, the real economic impact of stem decay is due to the fact that since the decayed portion is useless for most purposes, more trees or stands must be cut to obtain the required volume of wood for the mill. This raises the cost and lowers the efficiency of harvesting operations. Furthermore, since some decayed wood will almost surely be included in the harvest, the yield and value of the product are reduced.

## COMBATING STEM DECAY

Losses to stem decay can be minimized by measures that reduce competition and increase tree vigor by removal of trees with conks or large stem wounds, by minimizing stem wounding, and by pruning branches before they reach a diameter of 2 cm. Of course, the simplest means of combating stem decay is to harvest stands before they reach an age when decay will have a serious impact (i.e., the pathological rotation age).

Biological control of stem-decay fungi holds great promise for the future. It may eventually be possible to inoculate young seedlings with fungi antagonistic towards decay-causing fungi, and have these spread systemically throughout the developing trees, protecting them throughout their life.

## CASE STUDY: WHITE PINE

After dealing with the various aspects of stem decay in a generic manner, the compendium also provides specific information on each of the major tree species of Ontario. The following (summarized) information on white pine (*Pinus strobus* L.) stem decay is an example.

The largest study on white pine in Ontario found that the proportion of stem volume decayed ranged from less than 3% in the 41–60 year age class to only 7% in the 101–120 year age class. However, decay increased sharply to nearly 18% of stem volume in the 121–140 year age class; decay remained at this level until the 201–220 year age class, at which point it increased to 33% (Table 1).

There is no relationship between tree diameter and the extent of decay within a single age class. However, in even-aged stands, both the percentage of trees with stem decay and the percentage of stem volume decayed are greater in the slower growing trees.

Trunk decay is far more widespread than butt decay, and accounts for about 88% of the volume loss. Most of this decay is attributed to *Fomes pini* (renamed *Phellinius pini*), a member of the white-rot group (Fig. 2).

*Fomes pini* frequently gains entry to the stems through stem wounds and tops killed by the white pine weevil (*Pissodes strobi* Peck). Unfortunately, since *F. pini* seldom forms sporophores on the stems of living white pine, the absence of conks does not indicate freedom from stem decay.

In the management of white pine, prevention of weevil damage will not only be beneficial in terms of tree form; it will also reduce the incidence of stem decay. In any case, serious decay losses are unlikely if trees are cut before they reach 120 to 130 years of age.

## CONCLUSIONS

Similar specific information is provided for eight other conifers and thirteen hardwoods of commercial importance in Ontario. There is also a complete list of literature cited, an outline of how the theoretical annual loss of stumpage in Ontario to stem decay was calculated, a list of common and scientific tree species names, and a list of the decay-causing fungi that have both traditional names and proposed or accepted new names. This compendium should be of value to virtually every forester practicing in Ontario.

Table 1. Occurrence of decay and stain in the stems of 1,012 white pine in Ontario (from Basham 1991).

| Age class (years) | No. of trees | Avg stem vol. ($dm^3$) | Avg decay and stain[a] vol. ($dm^3$) | Stem vol defective (%) |
|---|---|---|---|---|
| 41-60 | 113 | 303.0 | 8.50 | 2.6 |
| 61-80 | 490 | 371.0 | 11.33 | 3.0 |
| 81-100 | 51 | 484.3 | 16.99 | 3.5 |
| 101-120 | 10 | 393.6 | 28.32 | 7.1 |
| 121-140 | 57 | 909.1 | 158.59 | 17.5 |
| 141-160 | 120 | 1367.9 | 240.72 | 17.6 |
| 161-180 | 110 | 1821.0 | 266.21 | 14.6 |
| 181-200 | 53 | 2347.7 | 345.50 | 14.7 |
| 201-220 | 8 | 2449.7 | 809.95 | 33.1 |

[a] Very little stain was present.

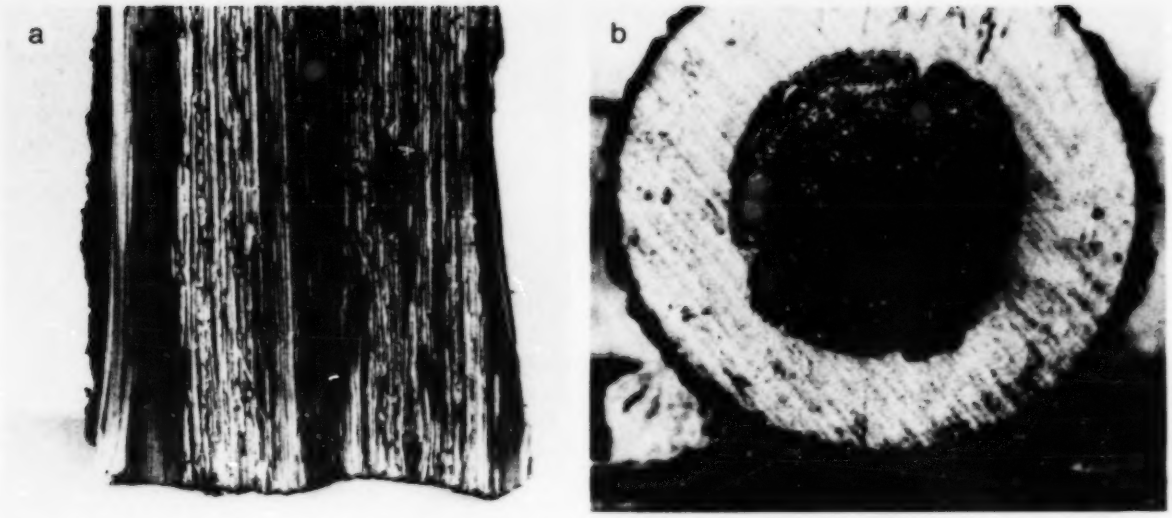


*Figure 2. White pine stem decay caused by* Fomes pini (Phellinus pini): *(a) transverse section of advanced decay, (b) closeup of radial section, showing pockets of cellulose in decayed wood.*

## REFERENCES AND FURTHER READING

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Jack Basham is a scientist (now retired) who spent most of his career conducting research on stem decays of native trees of Ontario.

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